STUDY OF THE CAUSE OF INSUFFICIENT PREDICTIVE VALIDITY OF THE DEVELOPMENTAL TESTS

—— Neuropsychological comparison of the developmental test for children with the adult intelligence test focusing on the distribution of the test items. ——

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Synopsis : This study aims to elucidate the cause of insufficient predictive validity of developmental tests (DTs) for infants and young children which are presently used in Japan.

It has long been said that the predictive validity of DTs for infants and young children was insufficient. The authors assumed that a neuropsychological comparison of DTs and adult intelligence tests would detect some means for verifying the cause of insufficient predictive validity.

In order to examine the neuropsychological distribution of the test items in those tests, the following two methods were decided upon:

1) To examine and classify all test items in the DTs using the Osgood-Kirk's model of communication functions.

2) To verify the cause of insufficient predictive validity of DTs, the degree of difference of DTs from the adult intelligence tests in terms of neuropsychology being used as the index.

The result of the study determined that the DTs (simplified and clinical) for infants and young children were different from the adult intelligence tests as far as neuropsychological distribution of test items is concerned. Among ten communication functions, DTs measured only two or three aspects. The largest percentage of the distribution in the test items of DTs was "Manual expression."

It can be said that the DTs measured different aspects of communication functions when compared with that of adult intelligence tests. Therefore this study revealed the cause of insufficient predictive validity of DTs in terms of neuropsychology.

Introduction

It has long been said that the predictive validity of development tests (DTs) was insufficient,[1-3] because any test presently used has some limitations and it is very difficult to cover all the aspects in terms of neuropsychology. There are many problems in testing infants and young children in particular.

This study aims to detect the cause of insufficient predictive validity which occurs in the developmental tests for infants and young children.

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The authors used the communication model[4-6] of the ITPA[7-10] (Illinois Test of Psycholinguistic Abilities) as the index for analyzing the neuropsychological distribution of the test items in the developmental tests currently used in Japan.

Kirk *et al.* developed ITPA in 1961. They pointed out that, in the past, schools had required psychologists to administer psychometric tests (such as the Stanford-Binet or WISC) for the purpose of placement of children in special classes or special groups. Therefore these tests had been used primarily for classification purposes.

ITPA is based on the concept of intraindividual differences. This concept led logically to psychometric tests that could measure a number of specific and discrete areas of neuropsychological development. Its principal use is to diagnose a child's psycholinguistic abilities so that remediation can follow.

When one person receives a message, interprets it, or becomes the source of a new signal to be transmitted, it deals with the psychological functions of individual which operate in communication.

According to Osgood-Kirk, there are 10 areas of communication functions and these functions reflect the learning disability of the children in perceiving, thinking, listening, talking, reading, writing, spelling, and arithmetic.

Table 1 Osgood-Kirk's model of communication functions

Representational Level	1 . Auditory Reception	the ability to understand auditory symbols such as verbal discourse
	2 . Visual Reception	the ability to gain meaning from visual symbols
	3 . Auditory Association	the ability to relate concepts presented orally
	4 . Visual Association	the ability to relate concepts presented visually
	5 . Verbal Expression	the ability to express concepts verbally, *i. e.* vocally
	6 . Manual Expression	the ability to express ideas manually
Automatic Level	7 . Grammatic Closure	the ability to make use of the redundancies of oral language in acquiring automatic habits for handling syntax and grammatic inflections
	8 . Visual Closure	the ability to identify a common object from an incomplete visual presentation
	9 . Auditory Sequential Memory	the ability to reproduce from memory sequences of digits of increasing length
	10. Visual Sequential Memory	the ability to reproduce sequences of nonmeaningful figures from memory

The authors considered it important to focus upon these 10 areas of communication functions in order to examine the developmental tests. This kind of study does not seem to have been tried before.

In Japan, kindergarten and other schools administer many kinds of psychological tests such as simplified developmental tests and group intelligence tests to all the children. When mentally retarded children or learning disability children are screened through simplified tests, the clinical developmental tests or individual intelligence tests and ITPA are administered for diagnostic purposes.

Unfortunately, no one has tried to exmamine the DTs from the standpoint of Osgood-Kirk's ten communication functions.

The authors considered it worthwhile to study what area of communication functions was mainly

measured in these tests, and assumed that if the tests covered only certain areas, they were not suitable tests and the predictive validity was subsequently insufficient.

The authors also considered that if the hypothesis were verified, it could be helpful to further restructure the developmental tests. It would also raise the predictive validity of DTs.

In order to make clear the Osgood-Kirk's model of communication functions, we would like to review them.

The model presented in Figure 1 demonstrates graphically the interrelationships of the various functions. The following is a description of the three dimensions in the model.

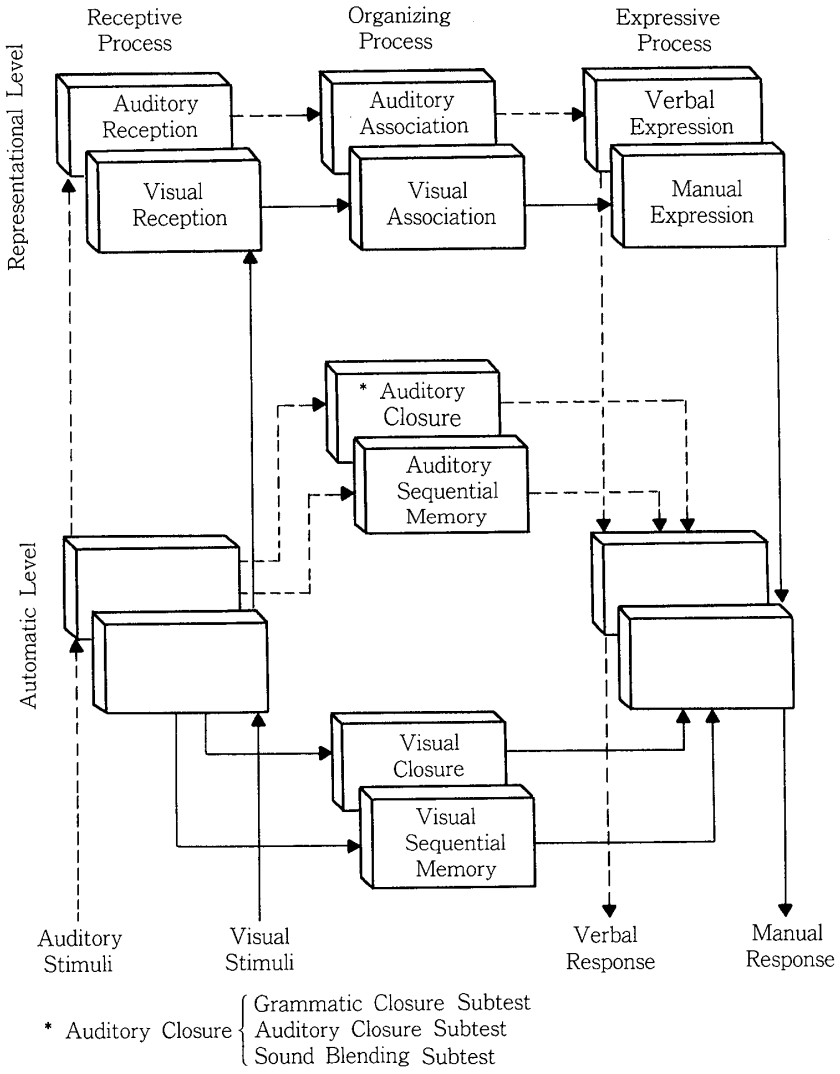

Figure 1 Osgood-Kirk's graphic representation of the functions which operate during communication activities

1. Channels of communication

These are the routes through which the content of communication flows. Included here are the modalities through which sense impressions are received as well as the forms of expression through

which a response is made. The channels may include various combinations of sensory input and response output. The major modes of input are auditory and visual; those of output are vocal and motor. Many combinations of input and output are possible, but the ITPA incorporates four channels: the auditory-vocal, the auditory-motor, the visual-vocal, the visual-motor.

2. Psycholinguistic processes

In analyzing behavior, which occurs in the acquisition and use of language, three main processes are considered:

(1) Receptive process: the recognition and/or understanding of what is seen or heard.
(2) Organizing process: the eduction of relationships from what is or has been seen or heard.
(3) Expressive process: the use of those skills necessary to express ideas verbally or by gesture or movement.

3. Levels of organization of communication habits

The degree to which communication behavior is organized within the individual, determines the level of functioning. Two levels are postulated.(1) The representational level: the behavior which requires more complex mediating process of utilizing symbols which carry the meaning. (2) The automatic level: the communication behavior requiring less voluntary but highly organized and integrated patterns; this includes such activities as visual and auditory closure, speed of perception, ability to reproduce a sequence seen or heard, rote learning, synthesizing isolated sounds into a word, and utilizing the redundancies of experience.

Materials and Methods

This study involved both developmental tests and intelligence tests. Both of them are divided into two different kinds of tests: simplified group tests and individual clinical tests.

In simplified developmental tests, Table 2 - 1, 13 kinds of tests which are used in Japan were analyzed using Osgood-Kirk's model of communication functions.

In clinical developmental tests, Table 2 - 2, six kinds of tests which are used in Japan were analyzed by the same methods.

In these tests, shown in Tables 2 - 1 and 2 - 2, corresponding age groups for each test item are designated.

The test items which seemed to belong to two areas were put into a category which more closely matches the definition of the model. When there are test items, which consist of several subitems, each subitem is independently classified neuropsychologically.

The adult individual intelligence: (1) Tanaka-Binet individual intelligence test and (2) WAIS were analyzed using the same methods mentioned above, and compared with the results of the DTs. The test items, which did not seem to be related to any of the 10 communication functions, were judged to be "Untested communication functions." They comprised test items in which the authors determined that no communication existed between examiners and children when the tests were administered. Examples of test items are "Being able to roll over" (age 1), "Being able to put on shoes" (age 2), "Being able to

Table 2-1 Simplified developmental intelligence tests, which were used in this neuropsychological study

	Name of the Tests	Authors	Published Year	Publisher	Age				
					0	1 • 2	3 • 4	5 • 6	Primary School
Simplified Developmental Test for Infant and Young Children	Developmental Prescreening Questionnaire (JPDQ)	Ueda R.	1980	Ishiyaku Shuppan	○	○	○	○	
	MN-Developmental Screening Test	Mukai Y.	1982	New Medical Sha	○	○	○	○	
	Aiikukai Simplified Developmental Test for Young Children	Ushijima Y. *et al.*	1949	Kaneko Shobo	○	○	○	○	
	Tsumori Mental Developmental Test for Young Children	Tsumori M. *et al.*	1949 1961	Dainihon Tosho	○	○	○	○	
	Japan Denver Developmental Screening Test (JDDST)	Ueda R.	1975	Ishiyaku Shuppan	○	○	○	○	
	Maekawa Simplified Developmental Test for Young Children	Maekawa K. *et al.*	1980	Nanzando	○	○			
	Enjoji Analytical Developmental Test for Young Children	Enjoji M.	1977	Keio Tsushin	○	○	○		
Group Intelligenece Tests for Primary School	New Tanaka-Binet Intelligence Test for Primary School (3-4 Grade) Children	Tanaka K. *et al.*	1985	Kaneko Shobo					○
	Osaka Kyoiku Kenkyujo Intelligence Test for Children (Primary School)	Yoshikura Y.	1961	Osaka-shi Kyoiku Kenkyujo					○
	TK Analytical Intelligence Test for Children (3-4 Grade)	Tanaka T.		Taken Shuppan					
	Kyoken Intelligence Test for Each Grade of Primary School. New Scale for 3-4 Gade	Sakakibara K. *et al.*	1984	Nihon Tosho Bunka Kyokai					○
	Kyoken G-Intelligence Test for 3-4 Grade	Okamoto	1974	Nihon Tosho Bunka Kyokai					○
	GI Integrated Intelligence Test for Each Grade (3-4 Grade)	Mogi M.	1982	Nihon Bunka Kagaku Sha					○

Table 2-2 Clinical developmental and intelligence tests, which were used in this neuropsychological study

	Name of the Tests	Authors	Published Year	Publisher	Age					
					0	1 · 2	3 · 4	5 · 6	8 · 10	Adult
Clinical Developmental Test for Infants and Young Children	MCC Baby Test	Koga Y.	1967	Dobun Shoin	○	○				
	Aiikukai Developmental Test for Young Children	Ushijima Y. *et al.*	1945	Kaneko Shobo	○	○	○	○		
	New K-Development Test	Shimatsu M. *et al.*	1985	Nakanishiya Shuppan	○	○	○	○	○	
	Integrated Mental Developmental Test for Young Children	Ushijima Y.	1961	Kaneko Shobo			○	○	○	
Individual Intelligence Test for Adult	Taken-Tanaka-Binet Intelligence Test	Tanaka Kyoiku Kenkyujo	1970	Tanaka Shuppan		○	○	○	○	○
	WAIS (Japanese Edition)	Kodama S.	1958							○

button up" (age 3), "Being able to brush teeth" (age 4), "Not crying when doctor injects" (age 4), "Being able to saw a log" (age 5).

Authors examined the cause of insufficient predictive validity of the developmental tests for children using the methods mentioned above. Communication function does not indicate intelligence but the authors considered that these two are closely related to each other. Therefore this kind of study seems to be acceptable. When the examiner administers the intelligence test, it is certain that the examinee's intelligence is measured through communication between examiner and examinee.

Osgood-Kirk's concept of the communication function is closely connected to functional locational of the cerebral cortex. It is significant to study the cause of the predictive validity of developmental tests, in terms of neuropsychology as shown in Osgood-Kirk's model.

Result and Discussion

1 . The neuropsychological distribution of the test items in the individual intelligence test for Adults (AIIT) (Tables 3 - 1, 3 - 2, Figs 2 - 1, 2 - 2)

Test items measuring "Auditory Association" comprised 58 out of 104 test items (55.8%), the largest percentage. Then "Verbal Expression" was 39/104 (37.5%), "Visual Association" was 12/104 (11.5%), "Auditory Sequential Memory" was 10/104 (9.6%), and "Visual Closure" was 9/104 (8.7%).

AIIT covers overall communication functions better than other tests. Consequently the neuropsychological distribution of test items in AIIT was used as the standard distribution in this study.

2 . The neuropsychological distribution of the test items in the simplified developmental test for

Table 3-1 The neuropsychological distribution of the test items in the simplified developmental tests

(%)

10 Areas of communication Function \ Age	0	1−2	3−4	5−6	8−10	Adult
Auditory Reception	23 (7.1)	50 (15.6)	33 (14.7)	1 (0.9)		
Visual Reception	23 (7.1)	33 (10.3)	11 (4.9)	8 (5.5)	254 (18.6)	3 (2.9)
Auditory Association			18 (7.1)	5 (4.5)		58 (55.8)
Visual Association					770 (56.5)	12 (11.5)
Verbal Expression	8 (2.5)	51 (18.0)	50 (22.3)	38 (34.5)		38 (37.5)
Manual Expression	107 (33.1)	81 (25.4)	50 (22.3)	19 (17.3)	52 (3.8)	
Grammatic Closure		3 (0.8)	8 (2.7)		135 (8.8)	4 (3.8)
Visual Closure			1 (0.4)	8 (5.3)	204 (15.0)	9 (8.7)
Auditory Sequential Memory		6 (1.9)	12 (5.4)			10 (9.6)
Visual Sequential Memory				12 (10.8)		
Untested Communication Function	174 (53.8)	122 (38.2)	78 (35.3)	38 (34.5)		
All Test Items	323 (100.0)	318 (100.0)	224 (100.0)	110 (100.0)	1363 (100.0)	104 (100.0)

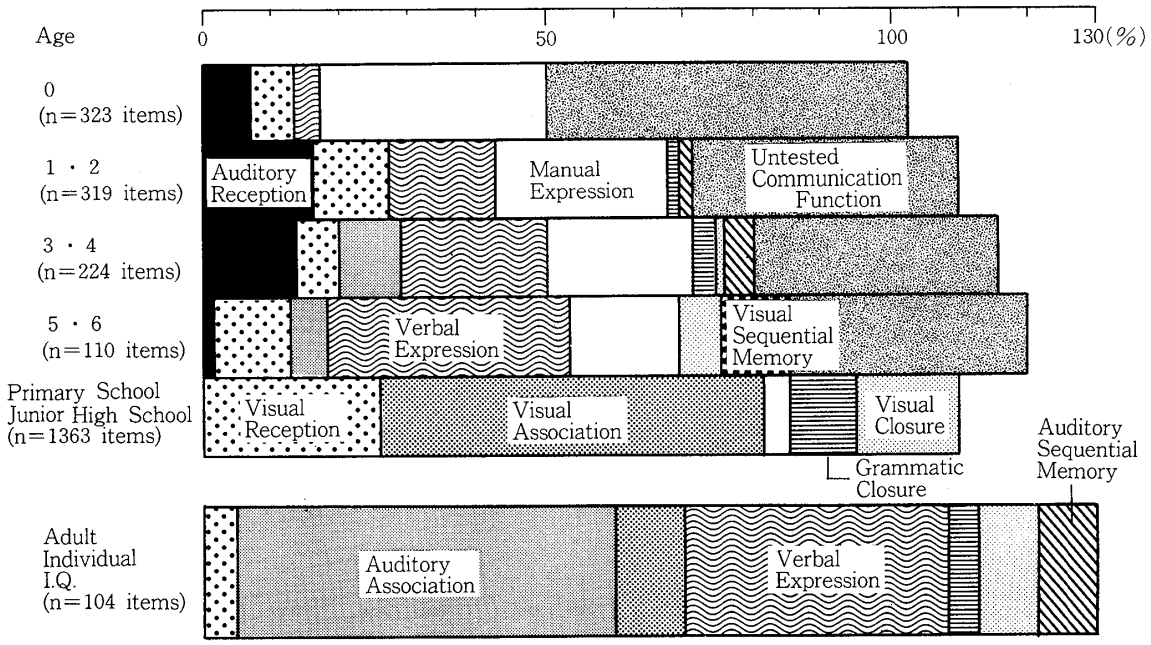

Figure 2-1 The neuropsychological distribution (by age groups and areas) of the test items in the simplified developmental tests for children (including group intelligence tests)

children aged 0 ~12 months (SDT 0 ~12m) (Table 3 - 1, Fig. 2 - 1)

"Untested Communication Function" was 174/323 (53.8%) and is shown to be about half. "Manual Expression" was 107/323 (33.1%). It showed the largest percentage in the communication functions. "Auditory Reception" and "Visual Reception" were the same proportion of 7.0%. There was a great difference observed between SDT 0 ~12 months and AIIT. "Auditory Association" comprised a large percentage in the AIIT, while there was no such function measured in the SDT 0 ~12 months.

3. The neuropsychological distribution of the test items in the clinical developmental test for children aged 0 ~12 months (CDT 0 ~12 m) (Table 3 - 2, Fig. 2 - 2)

Comparison between SDT 0~12 months and CDT 0 ~12 months, CDT 0 ~12 months showed a smaller percentage in the area of "Untested Communication Function" (28.9%), but unlike the AIIT, both "Auditory Association" and "Verbal Expression" were not measured. "Manual Expression" was about half, 162/322 (50.3%). "Visual Reception" was 62/322 (19.3%), "Auditory Reception" was only 18/322 (5.6%). "Auditory Association" and "Visual Association" were not measured. These data were in contrast to the AIIT. The high percentage of "Manual Expression" resulted from the fact that there were many test items which examined the performance of children, for example, when the examiners performed "bye bye,"children imitated them.

Table 3-2 The neuropsychological distribution of the test items in the clinical developmental tests and individual intelligence tests

(%)

10 Areas of Communication Function \ Age	0	1—2	3—4	5—6	8—10	Adult
Auditory Reception	18 (5.6)	157 (30.8)	30 (9.3)	14 (5.8)	5 (3.3)	
Visual Reception	62 (19.3)	133 (28.1)	64 (19.9)	32 (13.1)	13 (8.9)	3 (2.9)
Auditory Association			22 (6.9)	32 (13.2)	38 (24.7)	58 (55.8)
Visual Association				14 (5.8)	18 (11.7)	12 (11.5)
Verbal Expression	2 (0.6)	162 (31.8)	88 (27.4)	52 (21.5)	58 (37.7)	38 (37.5)
Manual Expression	162 (50.3)	81 (17.9)	35 (10.9)	23 (8.5)	9 (5.8)	
Grammatic Closure			10 (3.1)	5 (2.1)	14 (9.1)	4 (3.8)
Visual Closure		8 (1.2)	49 (15.3)	44 (18.2)	7 (4.5)	9 (8.7)
Auditory Sequential Memory		12 (2.4)	22 (8.9)	11 (4.5)	11 (7.1)	10 (9.6)
Visual Sequential Memory			40 (12.5)	63 (28.0)	27 (17.5)	
Untested Communication Function	93 (28.9)	5 (1.0)	5 (1.6)			
All Test Items	322 (100.0)	509 (100.0)	321 (100.0)	242 (100.0)	154 (100.0)	104 (100.0)

4. The neuropsychological distribution of the test items in the simplified developmental test for children aged 1 ~ 2 (SDT 1 ~ 2) (Table 3-1, Fig. 2-1)

"Untested Communication Function" comprised 122/319 (38.2%). "Manual Expression" which was often seen in the SDT 0 ~12 months decreased to 81/319 (25.4%). There were significant differences between SDT 0 ~ 12 months and SDT 1 ~ 2. On the other hand "Auditory Reception" increased through the higher age group 50/319 (15.6%). "Verbal Expression" which was only 2.5% in the SDT 0 ~12 months also increased to 51/319 (16.0%) in the SDT 1 ~ 2. Test items of "Grammatic Closure" and "Auditory Sequential Memory" were used for the first time, but only a few in number. Such items as "Auditory Association" which AIIT includes were not measured in the SDT 1 ~ 2.

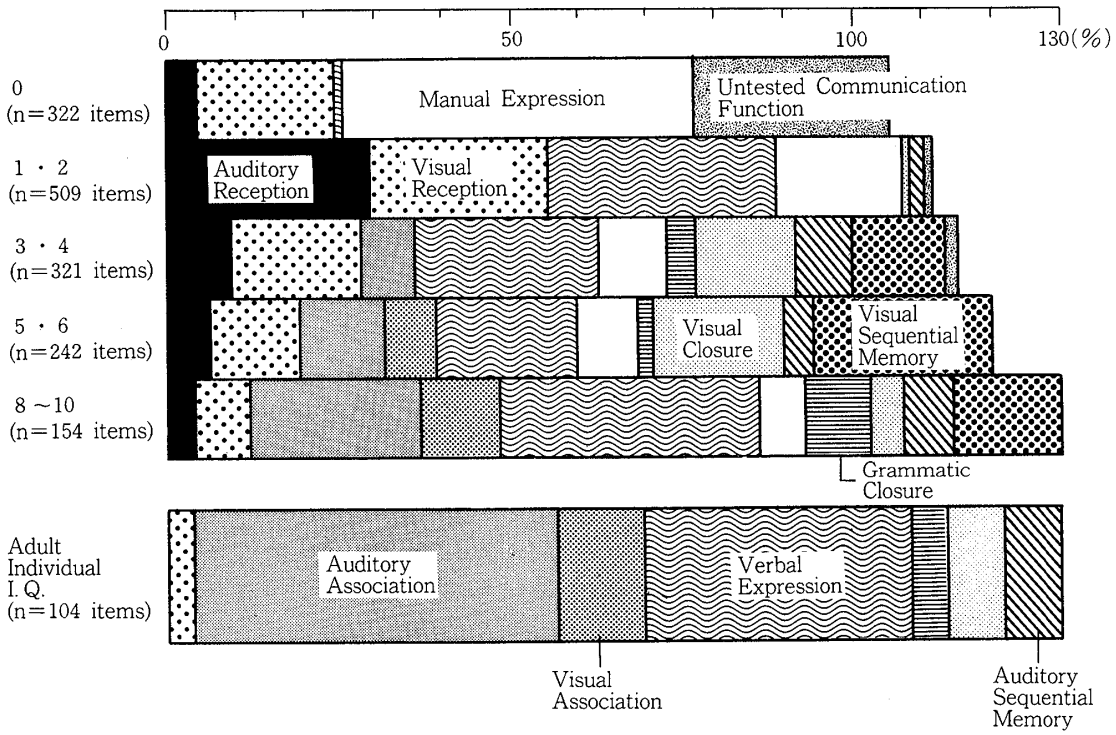

Figure 2-2 The neuropsychological distribution (by age groups) of the test items in the clinical developmental test for children (including individual intelligence tests)

5. The neuropsychological distribution of the test items in the clinical developmental test for children aged 1 ~ 2 (CDT 1 ~ 2) (Table 3-2, Fig 2-2)

"Verbal Expression" increased greatly compared to the CDT 0 ~12 months. It comprised 162 out of 509 (31.8%). This function was not measured in the CDT 0 ~12 months. "Auditory Reception" also increased to 157/509 (30.8%). "Visual Reception" which was 19.3% in the CDT 0 ~12 months increased to 133/509 (26.1%). There were significant differences between these two tests. On the contrary "Manual expression" which was 50.3% in the CDT 0 ~12 months decreased to 91/509 (17.3%). "Auditory Sequential Memory" which appeared for the first time in the CDT 1 ~ 2 was a low 12/509 (2.4%). "Auditory Association" was not measured.

It is natural that "Verbal Expression" increased through aging, because the children's spoken language usually improves remarkably after their first birthday.

6. The neuropsychological distribution of the test items in the simplified developmental test for children aged 3 ~ 4 (SDT 3 ~ 4) (Table 3 - 1, Fig. 2 - 1)

"Auditory Association" which was often seen in the AIIT first appeared in SDT 3 ~ 4 16/224 (7.1%). "Untested Communication Function" was 79/224 (35.3%). "Manual Expression" was 50/224 (22.3%). In the receptive processes, "Auditory Reception" was 33/224 (14.7%). This was larger than "Visual Reception" which was 11/224 (4.9%).

7. The neuropsychological distribution of the test items in the clinical developmental test for children aged 3 ~ 4 (CDT 3 ~ 4) (Table 3 - 2, Fig. 2 - 2)

"Untested Communication Function" decreased to 5 /321 (1.6%) in CDT 3 ~ 4. "Auditory Association" which was often used in AIIT first appeared in this test. Among the ten communication functions, "Verbal Expression" had the highest proportion of 88/321 (27.4%). Then "Visual Reception" followed with 64/321 (19.9%). This percentage contrasts with SDT 3 ~ 4. "Auditory Reception" in SDT 3 ~ 4 comprised a larger percentage than "Visual Reception." Then "Visual Association" was 49/321 (15.3%). "Visual Sequential Memory" first appeared in CDT 3 ~ 4. It comprised 40/321 (12.5%). For example, test items such as "Tapping on building blocks" in which the examiner shows children how to tap on the blocks placed in row, and which the children imitate, were used. "Auditory Sequential Memory" also increased to 22/321 (6.9%).

"Grammatic Closure" first appeared with a low 10/321 (3.1%) in this test.

8. The neuropsychological distribution of the test items in the simplified developmental test for children aged 5 ~ 6 (SDT 5 ~ 6) (Table 3 - 1, Fig. 2 - 1)

"Verbal Expression" increased through aging (34.5%). This percentage was similar to the percentage in AIIT. However, "Auditory Association" which often appeared in AIIT was only a low 5 /110 (4.5%). "Untested Communication Function" was still a high 38/110 (38.5%).

9. The neuropsychological distribution of the test items in the clinical developmental test for children aged 5 ~ 6 (CDT 5 ~ 6) (Table 3 - 2, Fig. 2 - 2)

At this stage, all of the ten communication functions were measured. Among them, "Visual Sequential Memory" was the highest 63/242 (26.0%). Then came "Verbal Expression" with 52/242 (21.5%), followed by "Visual Closure" with 44/242 (18.2%). Next, "Visual Reception" and "Auditory Association" were the same percentage with 32/242 (13.2%). "Visual Association" which appeared often in AIIT was only a low 14/242 (5.8%). It first appeared at this stage.

10. The neuropsychological distribution of the test items in the primary school group intelligence test (PGIT) (Table 3 - 1, Fig. 2 - 1)

The highest percentage among the ten communication functions was "Visual Association" with 770/1363 (56.5%). It was 11.5% in the AIIT. "Auditory Reception," "Auditory Association," "Verbal

Expression," "Auditory Sequential Memory," and "Visual Sequential Memory" were not measured at all, as these group tests were administered en masse in schools and had the limitation of dealing with large numbers of students per class. "Visual Closure" comprised 172/1363 (13.1%) in PGIT, while it showed 8.7% in AIIT.

Notwithstanding the group test limitations, "Manual Expression" was tested and comprised 52/1363 (3.2%). Test items such as "Figure of Maze" and "Incomplete Figure" comprised two categories each, so that the former consisted of "Visual Reception" and "Manual Expression" and the latter of "Visual Closure" and "Manual Expression."

11. The neuropsychological distribution of the test items in the individual intelligence test for children aged 8 ~10 (CIIT 8 ~10) (Table 3 - 2, Fig. 2 - 2)

The distribution of test items in CIIT 8 ~10 was similar to AIIT. "Auditory Association" which in AIIT comprised 58/104 (55.8%), was a much lower 58/154 (24.7%) in CIIT 8 ~10. This was a significant difference between AIIT and CIIT 8 ~10.

As a result of this study, the authors found that test item distribution in the developmental test for young children (simplified tests and individual tests) differed greatly from the adult test (simplified and individual tests).

This study revealed that the predictive validity of DTs was naturally insufficient from the standpoint of neuropsychology in the view of the authors, because DTs do not measure associative communication function.

Adult intelligence tests which were used as pilot tests in this study also showed great deviation in test item distribution. Another study is required on this problem.

This study may be useful to develop or restructure the organization of test items in the DTs (both simplified and clinical test).

In order to raise the predictive validity to a sufficient level in DTs, the authors have made several suggestions regarding rearrangement of the test items using the Osgood-Kirk's model of communication functions.

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